Status of XMASS experiment

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For the XMASS collaboration

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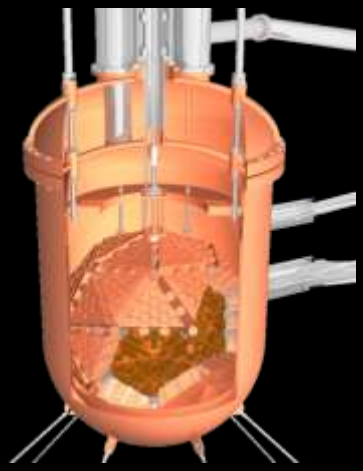
XMASS project

Y. Suzuki, hep-ph/0008296

Multi purpose low-background experiment with liq. Xe

- **X**enon **MASS**ive detector for solar neutrino (**pp/^{7}Be**)
- **X**enon neutrino **MASS** detector (**ββ decay**)
- **X**enon detector for Weakly Interacting **MASS**ive Particles (**DM search**)

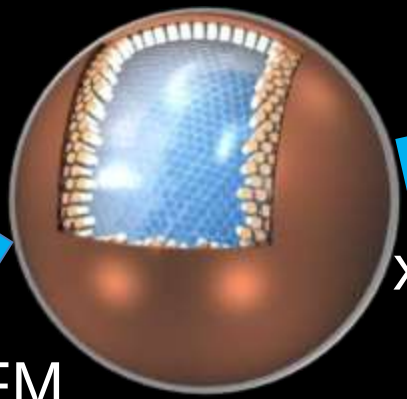
XMASS-I



Phase I: 0.1t fiducial mass (Total 835kg)

x10 FM

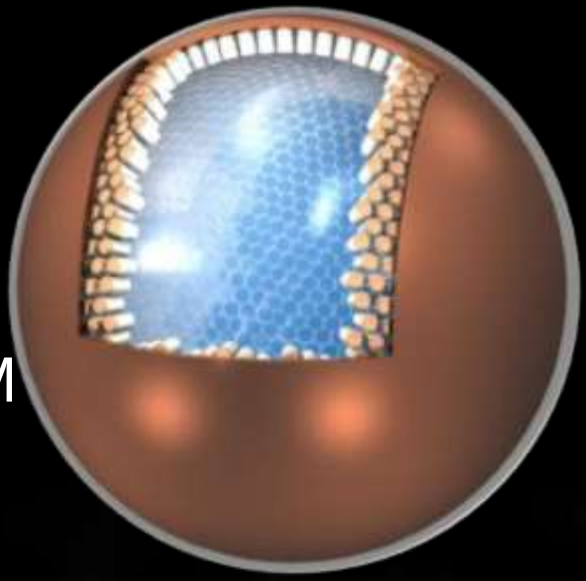
XMASS-1.5



1t FM (total 5t) 2015-

x10 FM

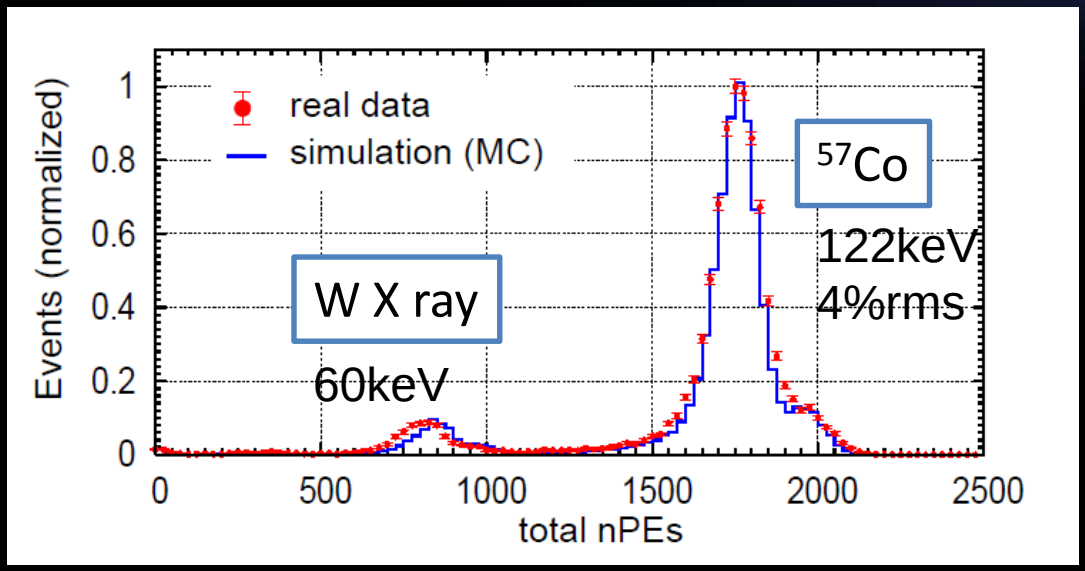
XMASS-II



Final goal:10t fiducial Mass (total 25t) 2020-

XMASS-I detector construction

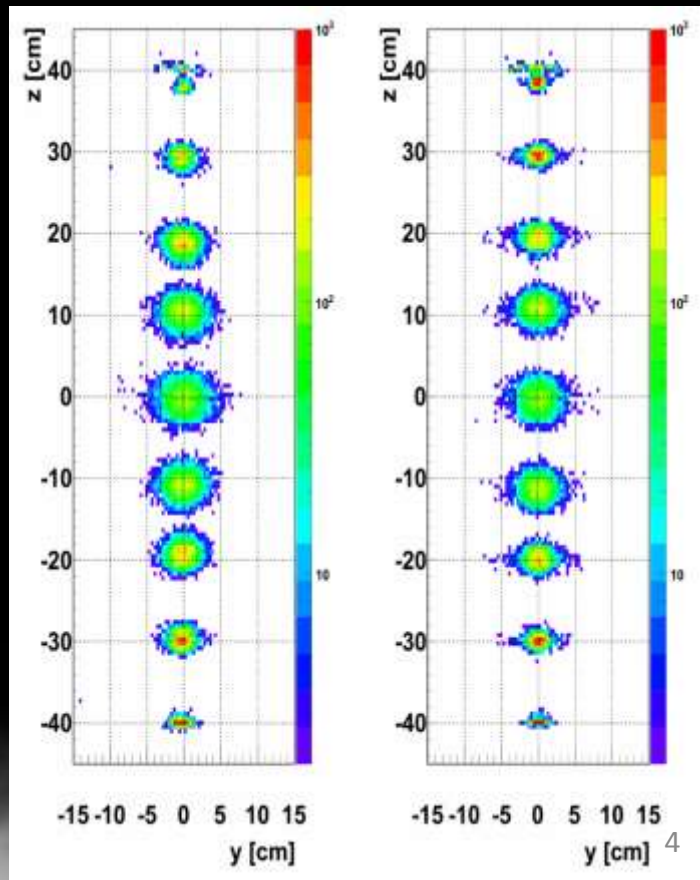
Demonstration of the detector performance



- The detector gave high photo-electron yield ~14.7p.e./keV
  Largest among DM detectors.
- Vertex recon. by pattern of p.e.
- Detailed description of the detector: NIMA 716 (2013) 78

Reconstructed Position distribution

Real Data Simulation



Physics results of XMASS-I

Published results (low threshold & low BG, no reconst.)

- Light WIMP search, Phys. Lett. B 719 (2013) 78
- Solar axion search, Phys. Lett. B 724 (2013) 46

Recent progress (low background in deep inside)

- Inelastic scattering on ^{129}Xe
- Vector boson super-WIMPs (NEW!)

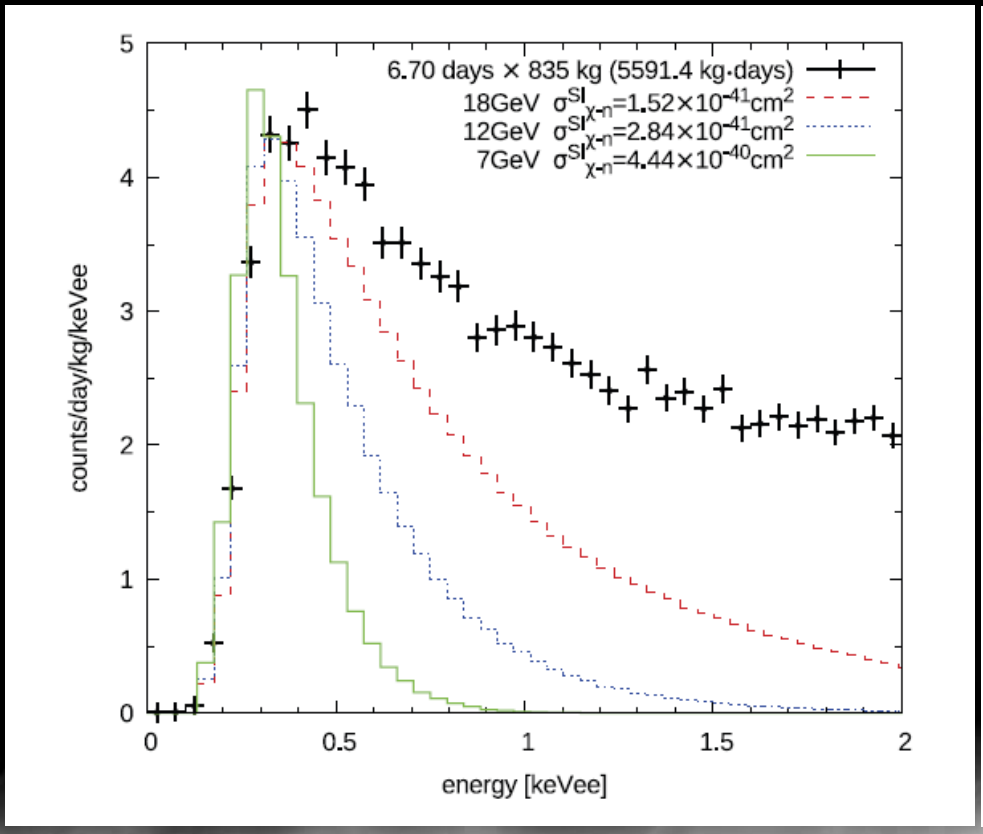
Results to be shown soon

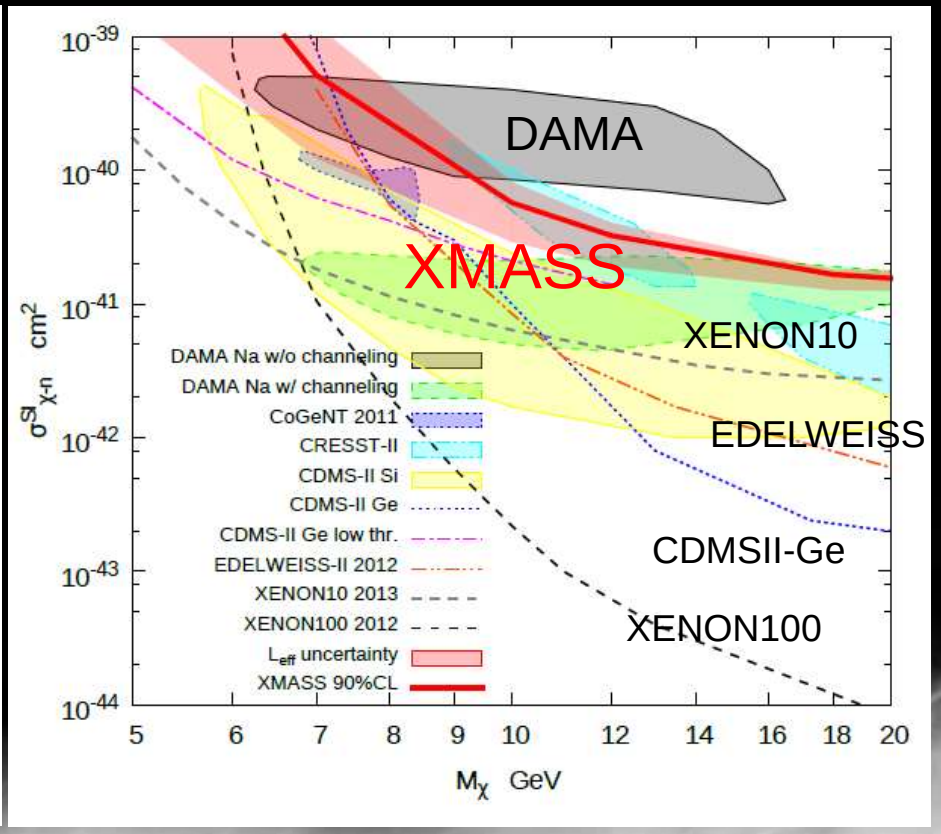
- Seasonal modulation with 835kg LXe
- Fidicual volume cut analysis (heavy WIMPs)

Phys. Lett. B 719 (2013) 78

Light WIMP search

- All the volume (835kg of LXe w/o fiducialization), >=4hits.
- Large p.e. yield, 14.7p.e./keV, thre. confirmed by LED's data
  ➔ low Energy threshold 300eVee was achieved.
- Simple cut to remove Cherenkov events was used.

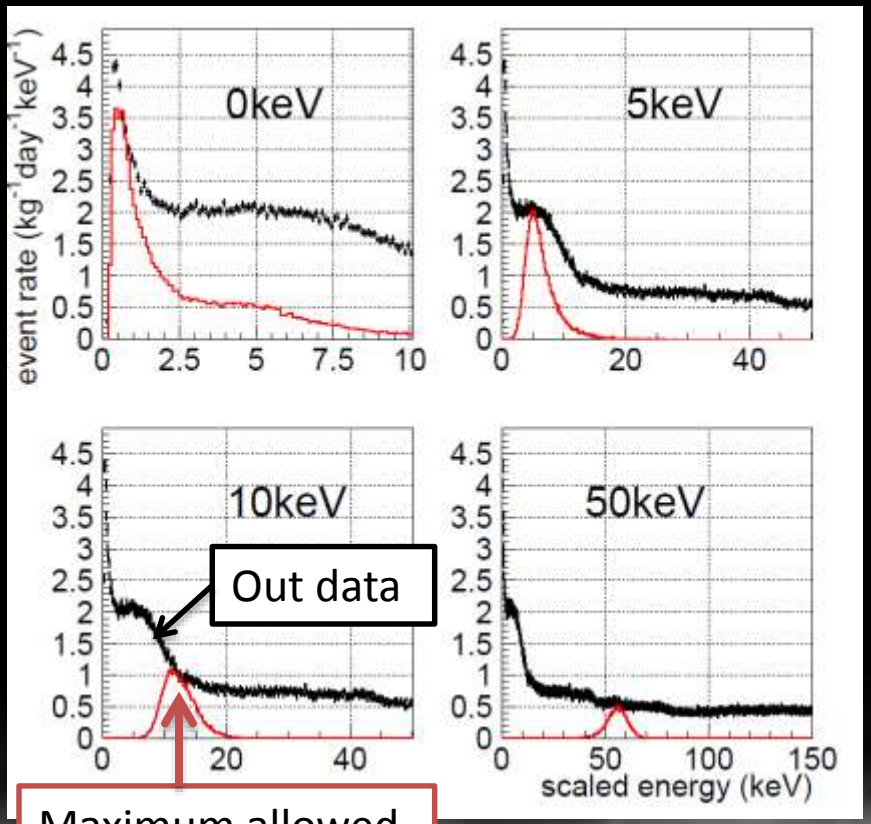


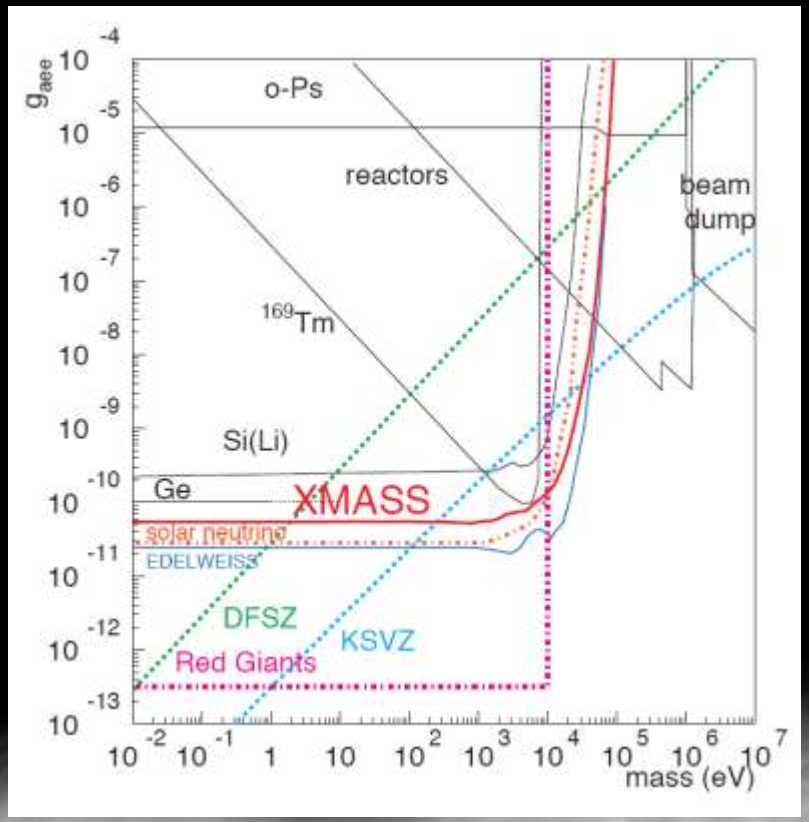


Phys. Lett. B 724 (2013) 46

Solar axion search

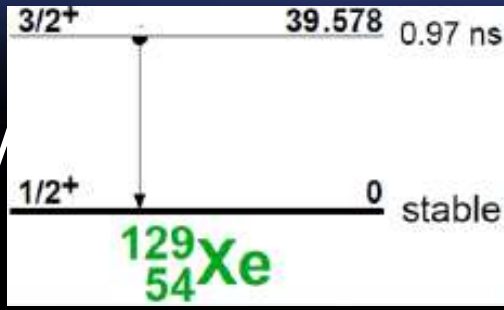
- Same data set as the light WIMPs search
- Generated in the Sun by bremsstrahlung and Compton effect, observed by axio-electric effect in XMASS.
- Strong experimental constraint <40keV

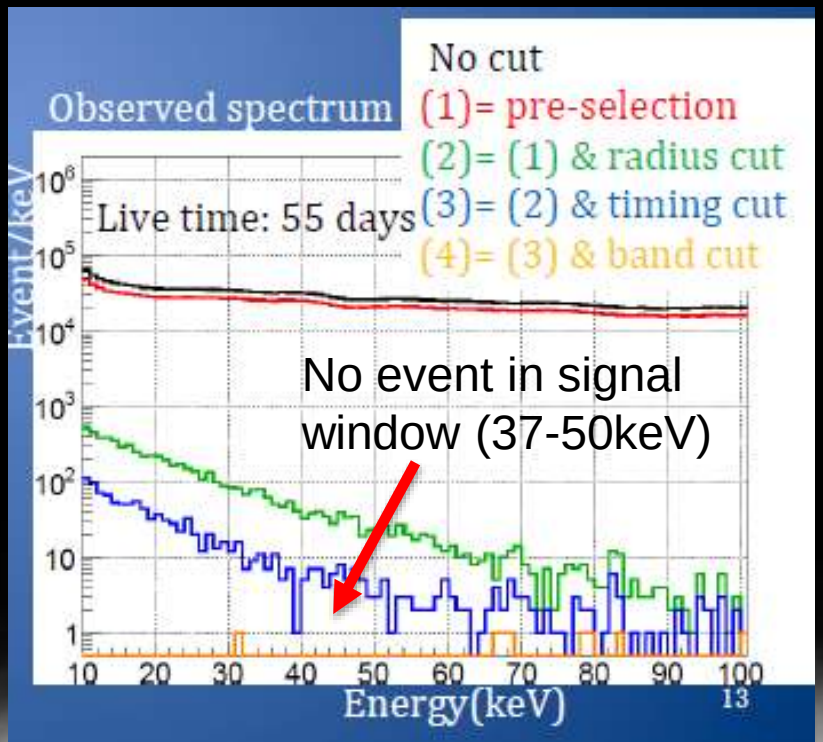


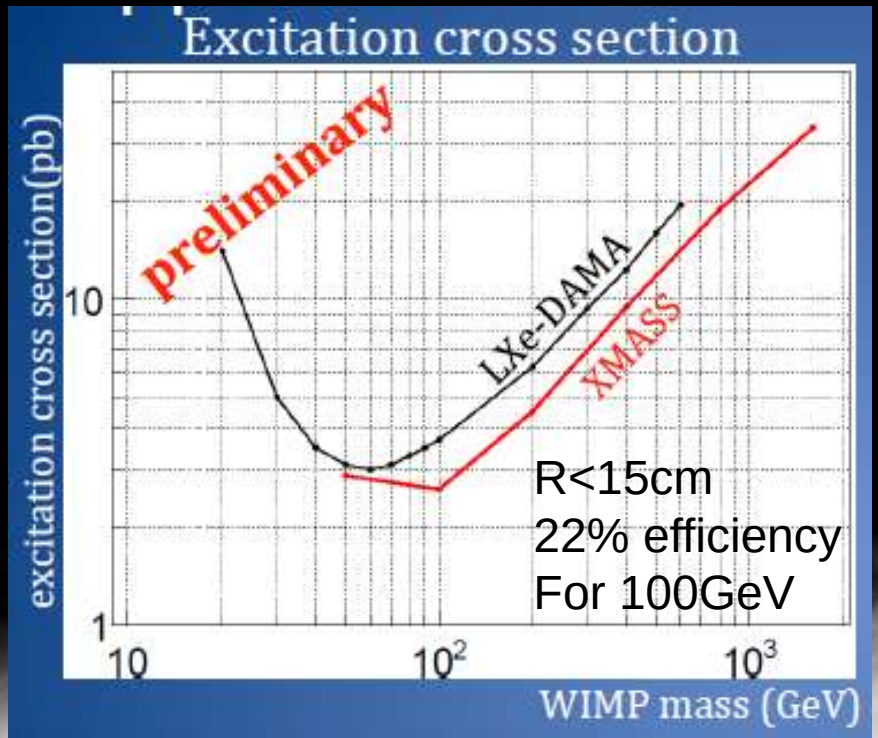


Inelastic scattering

- WIMPs would cause inelastic scattering on ^{129}Xe. Nuclear recoil as well as 40keV γ ray emission are expected. Peak search @40keV
- Various cuts are used (reconstructed radius cut, timing cut, and pattern cut "band cut")
- Another way for study on SD interaction.

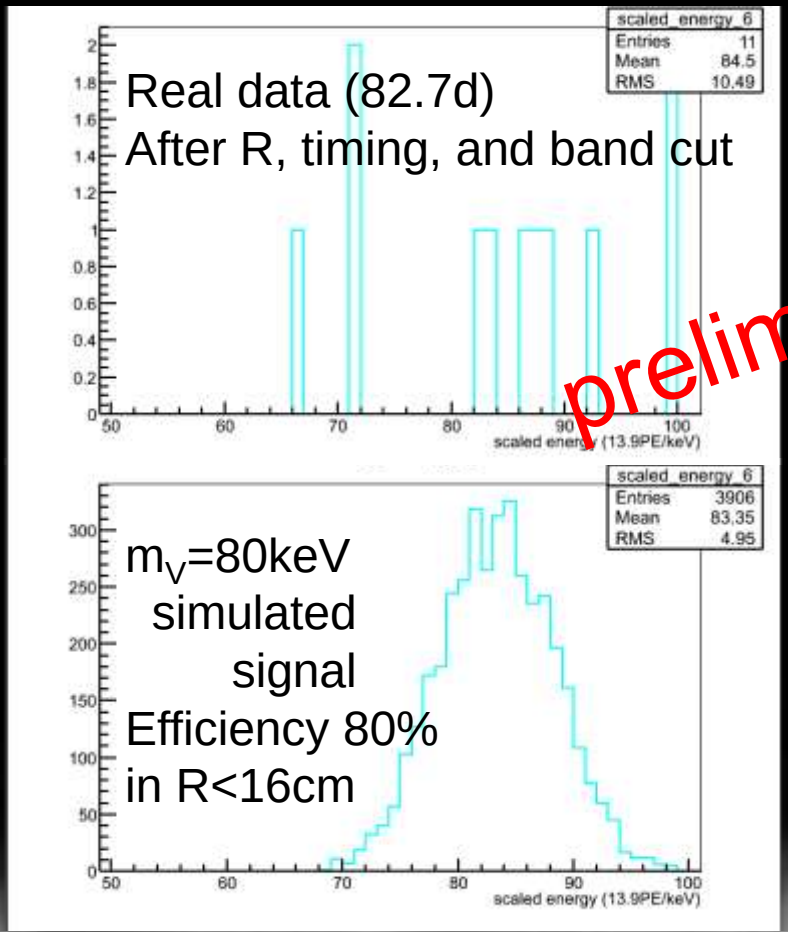


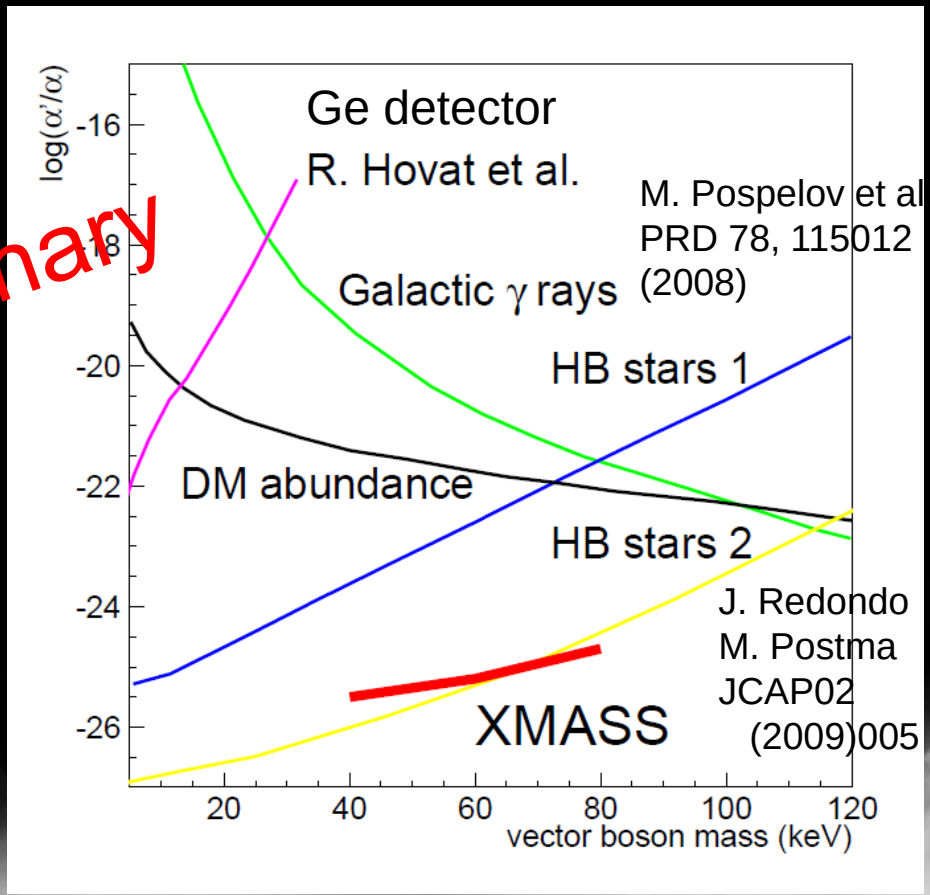




Vector super-WIMPs

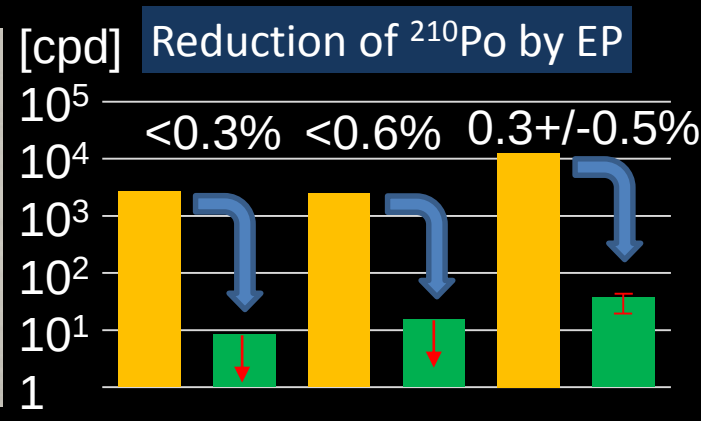
- CDM has problems on galactic scales. Lighter DM (keV-MeV) gives better understanding. Detectable by photo-electric effect. Similar cuts as inelastic study were used.
- The 1st exp. result to constrain DM in 40-80keV. (>80keV soon)

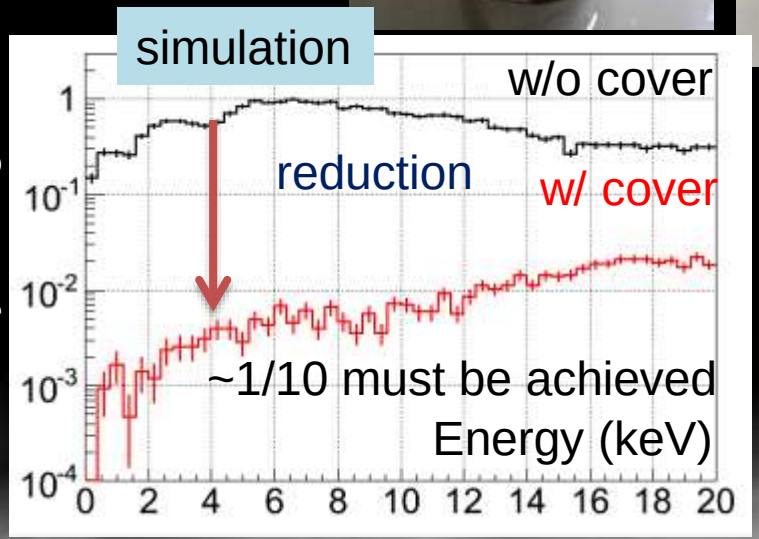


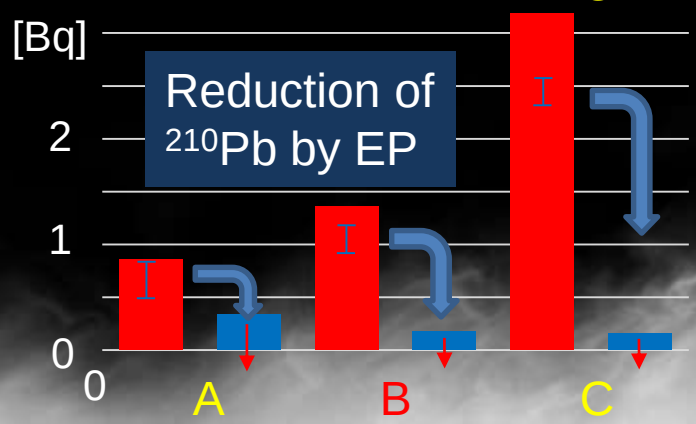


Refurbishment of XMASS-I

- Most of BG is caused by low energy β from Al seal of PMTs.
- ~1/10 of the background: radon daughters on the surface.
- Confirmation/establishing surface treatment for XMASS1.5.

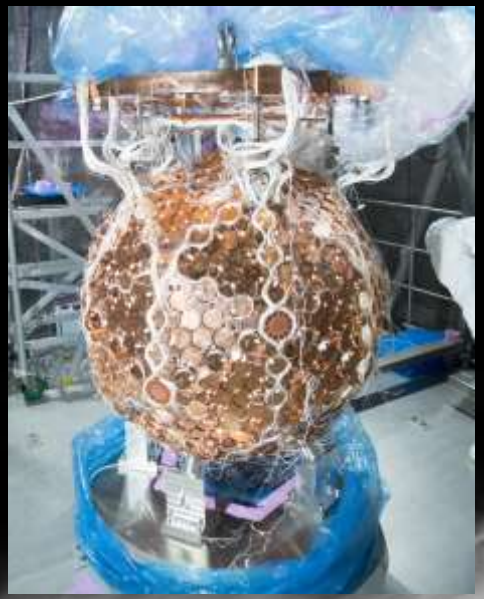






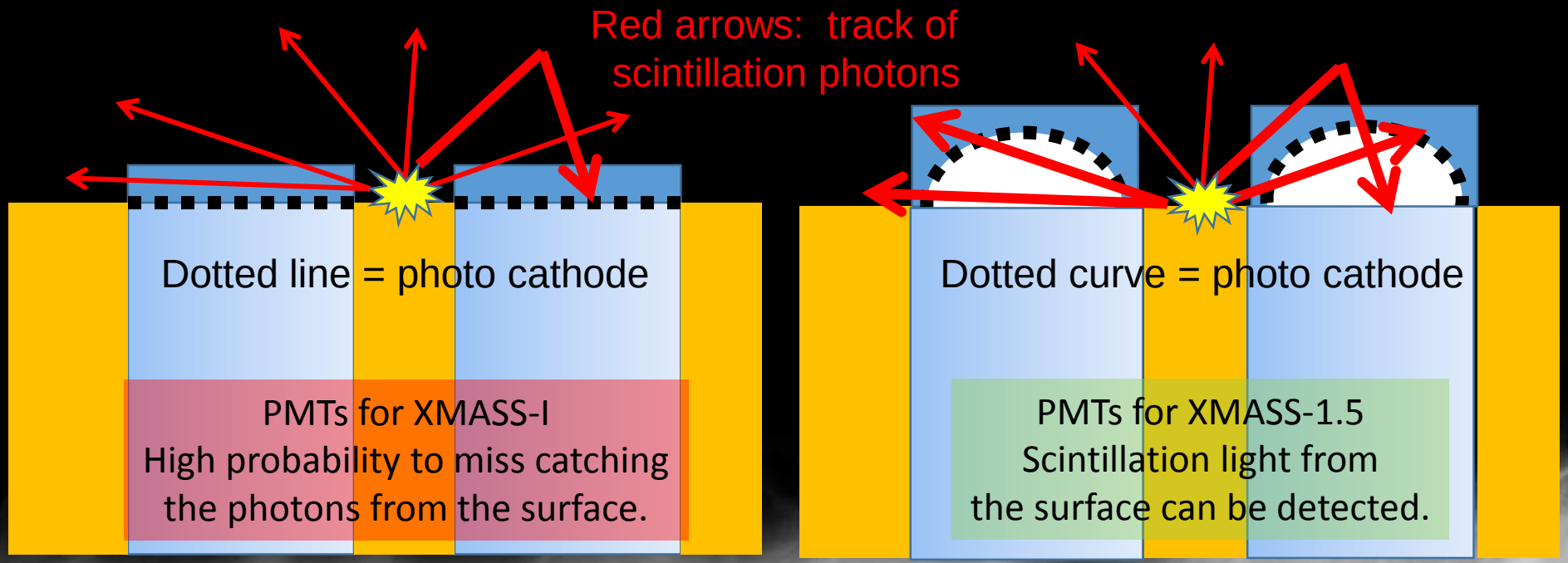
Status of refurbishment work

- We are almost finishing the refurbishment work.
- In this week the detector will be hung up to the original place and chambers will be set.
- Data taking will be resumed in this fall.



XMASS-1.5

- 5ton of liquid xenon (1ton of fiducial mass)
- Background reduction
  - No dirty aluminum, no suspicious GORETEX
  - Finite amount of surface BG must be assumed.
  - Round shape PMTs for robust identification of surface BG.

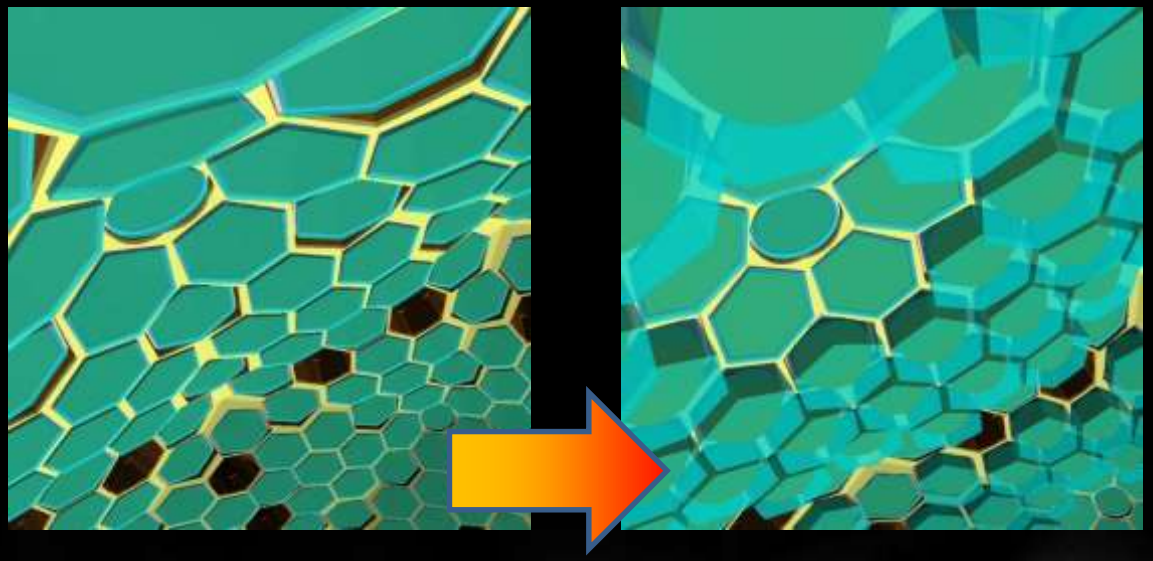


Impact on BG reduction

- MC simulation with convex-concave PMTs.
- Photons caused by an event happening in between PMTs can be caught by 40-48% prob. by adjacent three PMTs.

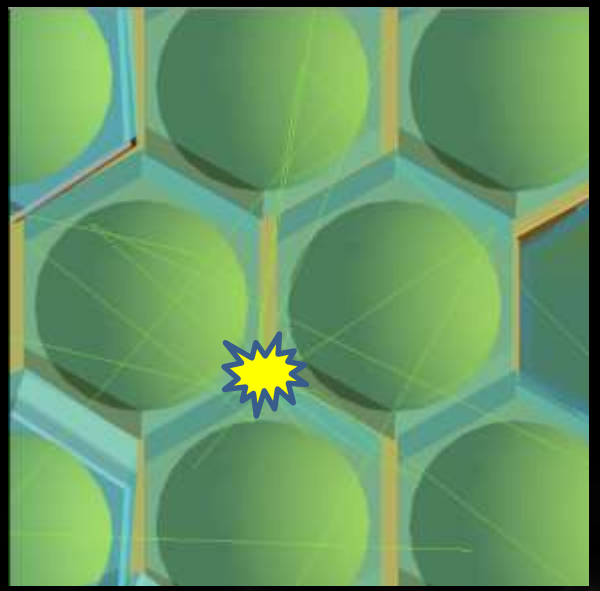
➔ Easier/robust identification of surface background.

- Optimization of PMT shape is ongoing.



XMASS-I
some PMTs not shown

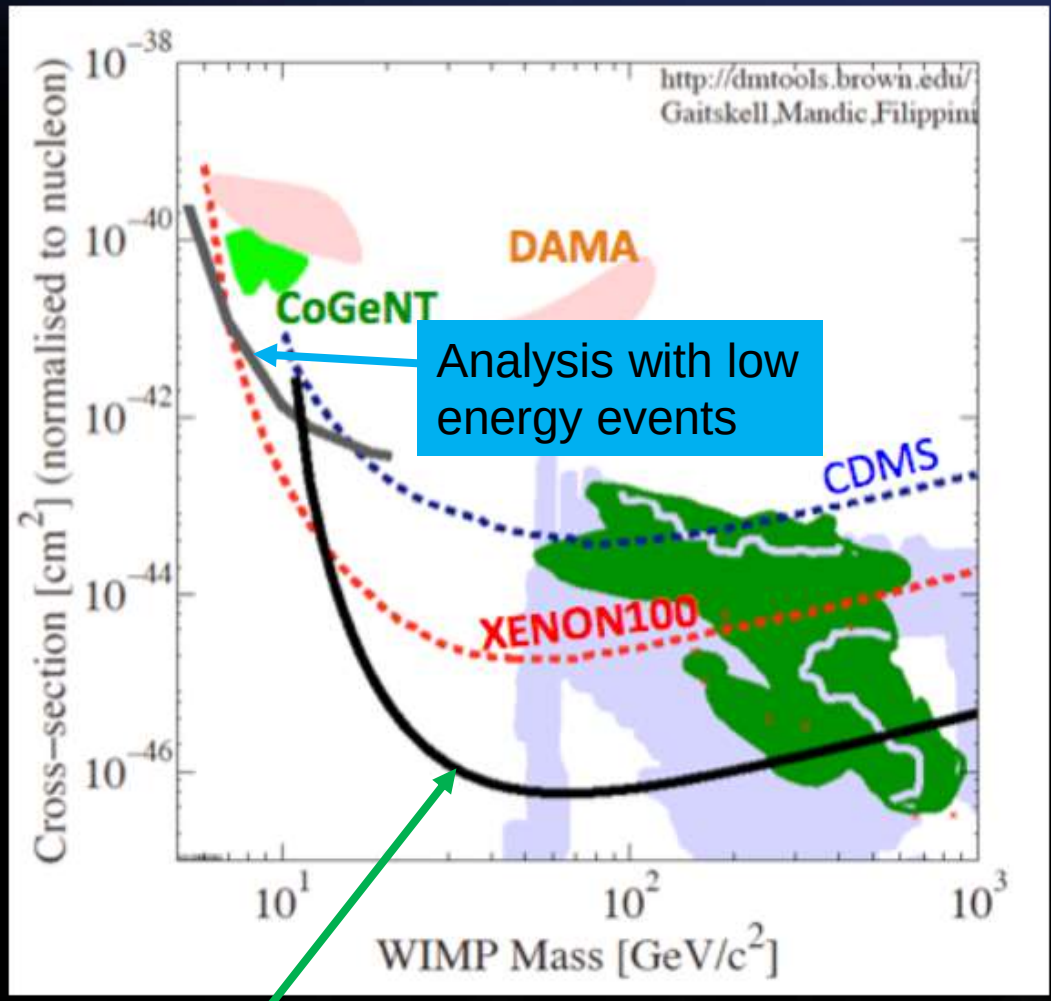
XMASS-1.5
Dome shape PMTs



Performance of BG rejection for surface BG is under study.

Sensitivity of XMASS-1.5

- Heavy WIMPs will be searched for using fidicial cut analyses.
  - $\sigma_{SI}<10^{-46}cm^2$
- Light WIMPs will be searched for at low energy of all volume data.
  - σ_{SI}~a few x $10^{-42}cm^2$
- ~2 orders of magnitude better for ALPs.
- Prototype of XMASS-II.
- Plan to start in 2015.



Analysis with fiducial cuts
(2keV energy threshold, 1yr exposure)

Summary

- XMASS-I has high light yield and low threshold. Physics results as demonstration of its performance.
  - Light WIMPs, solar axion, inelastic scattering, and vector bosons.
  - Seasonal modulation and fiducial volume analysis will come soon.
- Refurbishment work for confirmation of BG and establishment of surface treatment is ongoing.
  - Data taking will resume in this fall. Seasonal modulation, etc.
- XMASS-1.5 is planned to start in 2015. It has a sensitivity σ_{SI}~10^{-46}cm^2 in 1yr exposure.